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Effect of Plant-derived smoke solution on root of *Ipomoea marguerite* cuttings under Cobalt Stress

Muhammad Mudasar Aslam¹, Abaseen Akhter¹, Muhammad Jamil², Amna Khatoon¹, Ijaz Malook² and Shafiq Ur Rehman¹

¹ Department of Botany, Kohat University of Science and Technology, Kohat 26000, Pakistan

² Department of Biotechnology and Genetic Engineering, Kohat University of Science and Technology, Kohat 26000, Pakistan

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Abstract: The effect of plant derived smoke solutions on seed germination and seedling vigor is well documented. The present study was designed to find out the effect of *Cymbopogon*-derived smoke solution (1:500 dilution) on root of *Ipomoea marguerite* under CoCl_2 (10, 20 and 30 ppm). Inhibitory effect of CoCl_2 was observed on number of adventitious roots, numbers of lateral roots and adventitious root length as the concentration of CoCl_2 (10, 20 and 30 ppm) increases. It was observed that 1:500 dilution of smoke significantly increased number of adventitious roots, numbers of lateral roots and adventitious root length. Plant derived smoke solution alleviated significantly inhibitory effects of CoCl_2 at lower concentration (10 and 20 ppm). These results suggest that plant derived smoke dilution (1:500) showed positive effects and alleviated the inhibitory effect of CoCl_2 on plant cuttings.

Key words: Alleviating solution, CoCl_2 , seedling length, smoke solution

Introduction

It was a novel discovery that plant-derived smoke solution is responsible for promoting seed germination in different crops (De Lang and Boucher, 1990) and has hastily captured the consideration of plant biologist for its astonishing and amazing effects. Sparg et al. (2005) reported that the plant derived smoke solution have also post germination effects on plants and involved in enhancing seedling vigor. Similar results were published by Blank and Young (1998) that smoke play a major role in the

emergence and the development of diverse grasses. Published data revealed smoke solution stimulates flowering in different plant species (Keeley, 1993), enhanced rooting (Taylor and Van Staden, 1996) and involved in somatic embryogenesis (Senaratna et al., 1999). Biochemistry of Smoke solution illustrates that thousands of diverse compounds are present in smoke and many attempts are made to categorize the important active compounds (Preston et al., 2004).

*Correspondence to: Shafiq Ur Rehman, Department of Botany, Kohat University of Science and Technology, Kohat 26000, Pakistan; E-mail: drshafiq@yahoo.com

The large amounts of heavy metals accumulation in the environment is due to different type of anthropogenic activities which is important for society. Different plant species when expose to heavy metals show diverse responses towards their exposure. Cobalt is considered as an important heavy metal known for its highly toxic nature. This metal may persevere and deposit in the environment for long periods of time posturing as stress on the veracity of the environment and on the general public health. Higher concentration of this metal, however, may prove toxic and harshly hinder with various physiological and biochemical pathways (Jayakumaret al., 2008). Adverse effects of higher concentration of cobalt (upto 750 $\mu\text{g L}^{-1}$) have been reported on some plants (Jayakumar and Vijayarengan, 2006). Jayakumaretal. (2008) observed that seed germination and length of radical and plumule of ragi and paddy decreased significantly at higher concentration.

As plant-derived smoke solution is known as growth regulator and alleviated inhibitory effect of many compounds. In the present study affect of smoke solution and CoCl_2 were observed on number of adventitious roots, lateral roots and length of adventitious roots. It was also studied that alleviating solution of smoke might reduced inhibitory effect of CoCl_2 .

Material and Methods

Collection of Plant Material

Aerial parts of *Cymbopogon jawarancusa* were collected from Kohat district near Kohat University of Science and Technology (KUST), Kohat, Pakistan.

Preparation of Concentrated Plant-Derived Smoke Solution

An aqueous smoke solution was prepared from semidry plant material by heating 333g of plant material in furnace

which bubble through 1L distal water (Tieuet al., 1999) with slight modification. The concentrated smoke solution was then filtered through sterilized filter paper in clean sterilized bottle and was stored at 4 $^{\circ}\text{C}$ in a refrigerator. Concentrated smoke solution was diluted further to 1:500.

Collection and Preparation of Cuttings

Cuttings materials were taken from fresh and disease free vegetative tips of *Ipomoea*. All cuttings were taken in uniform length (27 cm) and leaves were removed except the upper two.

Experimental Procedure

Experiments on *Ipomoea* cuttings were conducted in 250 ml flasks to investigate effect of effect of *Cymbopogon*-derived smoke solution (1:500 dilution) on root of *Ipomoea* cuttings under CoCl_2 (10, 20 and 30 ppm). Each treatment contained 2 cuttings and was replicated 6 times. Control was also planted in each case. The basal ends of cuttings were dipped in the flask up to three nodes. The observation was recorded after each 24 h and all the experiments were conducted at temperature of 30-35 $^{\circ}\text{C}$. Data of adventitious root length and numbers of lateral roots were taken after 8 days.

Results were evaluated through analysis of variance (ANOVA) to find out the significance level of the data.

Results and Discussion

Effect of Plant-Derived Smoke Solution on Roots

Results showed that *Cymbopogon*-derived smoke solution significantly increased number of adventitious roots (Fig. 1A), number of lateral roots (Fig. 1B) and length of adventitious roots (Fig. 1C) of *Ipomoea*. It was found that 1:500 dilution of *Cymbopogon* derived smoke solution significantly increased number of

adventitious roots and number of lateral roots. It was noted that emergence of the lateral roots occur at 4th day of the experiment (Fig. 1B). It was also observed that effect of smoke solution was higher at the beginning but it slow down with the passage of time on number of adventitious roots and number of lateral roots (Fig. 1 A and B). It has been documented that plant-derived smoke promotes seed germination of a broad range of weed species (Kepczynskiet al., 2006). It was also suggested that smoke may cause activation of such enzymes that are helpful in fast emergence of the radical and thus increased the number and length of adventitious roots. These findings are in accordance with the results of Taylor and Van Staden (1995) who suggested that smoke-derived extracts can promote and elongate the rooting process of *Vigna radiate*. Baxter and Van Staden (1994) also observed that *Themeda triandra* seed showed significant response in seedling vigor (Root and Shoot length) when treated with smoke solution without any abnormalities as compare to the control. This data is supported by the results of Kulkarni et al. (2006) who reported that different plant-derived smoke solutions help in the stimulation of maize root.

Effect of CoCl₂ on Roots

It was found that CoCl₂ concentrations (10, 20 and 30 ppm) have inhibitory effect on number of adventitious roots (Fig. 2A), number of lateral roots (Fig. 2B) and length of adventitious roots (Fig. 2C). It was observed that as the concentrations of CoCl₂ moves from lower (10 ppm) to higher (30 ppm), its inhibitory effect increases on number of adventitious roots. Lateral roots of *Ipomoea* cutting were significantly affected by 30 ppm of CoCl₂ and totally inhibit/ stop the emergence of lateral roots.

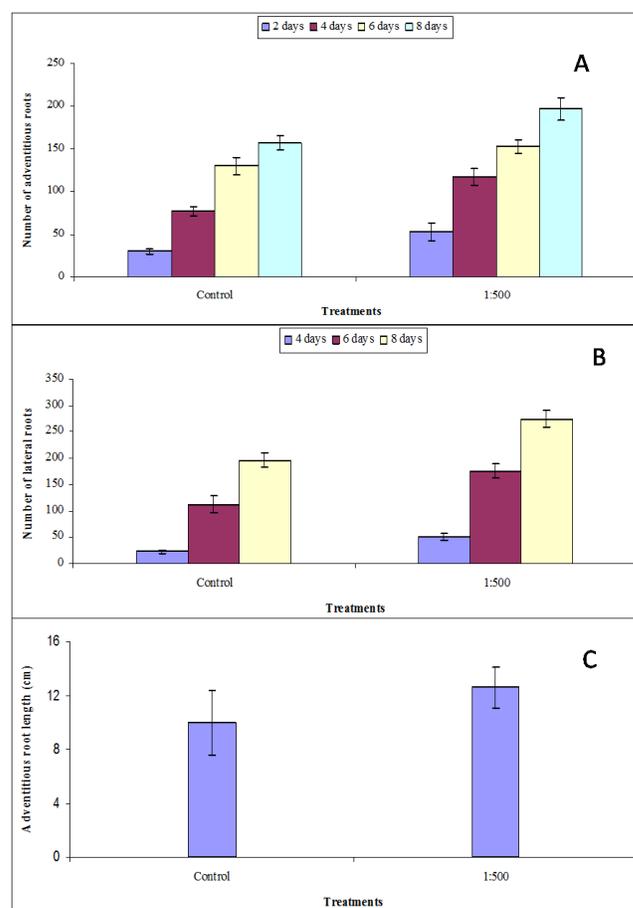


Fig. 1. Effects of Plant-derived smoke dilution (1:500) on number of adventitious roots (A), lateral roots (B) and length of adventitious roots (C) of *Ipomoea* plant cuttings. Error bar (I) are showing standard error.

Similar effects were observed in case of adventitious roots length. Jaykumar et al. (2008) reported that cobalt at higher concentrations has suppressed the seedling growth and dry weight of ragi and paddy seedlings. These results are similar to the results of Sharma and Dubey (2005), who reported that excess amount of heavy metal (Pb and Cd) in plants can affect growth and water balance which causes leaf chlorosis, necrosis and abscission. Neelima and Reddy (2003) suggested that heavy metals showed drastic effects at high concentrations and longer duration with regard to seedling

growth and metabolism. These results are according to the findings of Ayaz and Kadioglu (1997), who reported that accumulation of the heavy metals at higher concentration, can be toxic for plant growth due to their adverse effects on plant development and growth.

Effect of Smoke under Cobalt Stress

Alleviation solution was used to minimize the inhibitory effect of different CoCl_2 concentrations. *Cymbopogon*-derived smoke solution significantly ($p \leq 0.05$) alleviated inhibitory effect of concentrations (10, 20 and 30 ppm) on number of adventitious roots (Fig. 3A). Smoke dilution (1:500) also alleviated inhibitory effect of 10 and 20 ppm of CoCl_2 on number of lateral roots (Fig. 3B). Negative effect of CoCl_2 was also alleviated on length of adventitious roots by smoke dilution (Fig. 3C). It may be due to the presence of different compounds present in plant-derived smoke solution, which reduce the inhibitory nature of CoCl_2 or stop/minimize the uptake of CoCl_2 concentrations by roots.

It was concluded that *C. jawarancusa*-derived smoke solution have positive effect on number of adventitious and lateral roots and also on length of lateral roots. It was also concluded that smoke solution can alleviate CoCl_2 stress on the above mentioned parameters of *Ipomoea* cuttings.

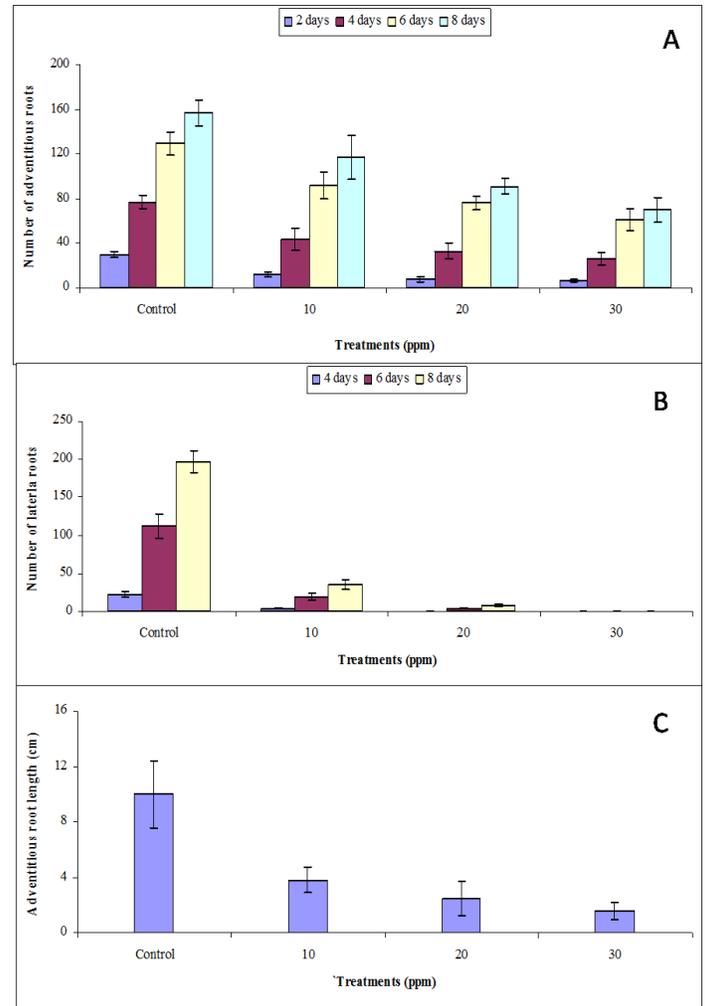


Fig. 2. Effect of CoCl_2 concentrations (10, 20 and 30 ppm) on number of adventitious roots (A), lateral roots (B) and length of adventitious roots (C) of *Ipomoea* plant cuttings. Error bar (I) are showing standard error.

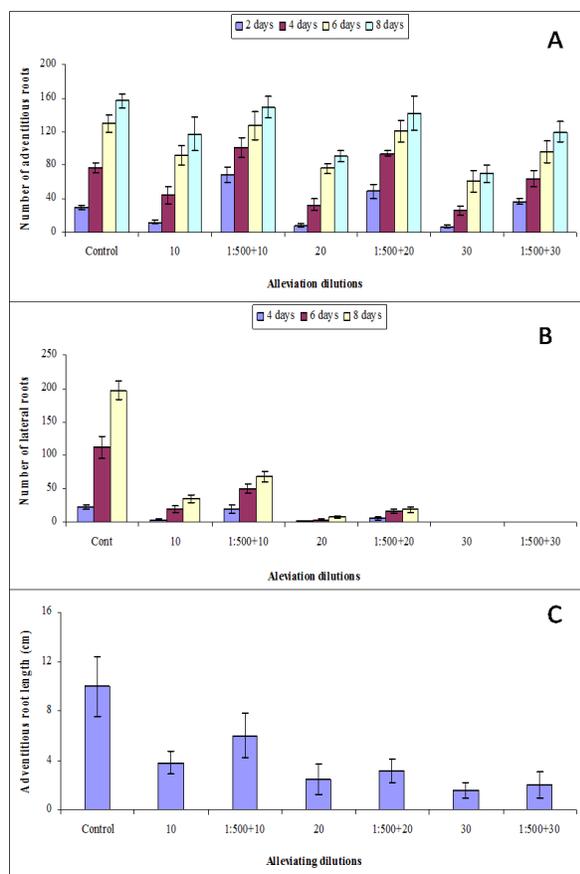


Fig. 3. Effect of alleviation solution (Smoke + Cobalt) on number of adventitious roots (A), lateral roots (B) and length of adventitious roots (C) of *Ipomoea* plant cuttings. Error bar (I) are showing standard error.

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